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Enhanced TAPS Software with Flipped Classroom Approach

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Abstract: This research focus on the invention and development of enhanced Technology Assisted Problem Solving (TAPS) software integrated with the flipped classroom approach to enhance the visualization and problem solving in engineering. The enhanced TAPS software, which incorporates digital media technologies and new pedagogical concepts, was designed according to the blended learning settings. This software consists of interactive environment embedded with 2-D and 3-D animation. Flipped classroom, one of the models of blended learning, continues to be one of the popular learning pedagogies in tertiary education. Flipped classroom encourage the active learning environment by promoting the students' participation in classroom activities and outside classroom interaction. In engineering education, one of the most common challenges that students encounter is having difficulty in visualize the engineering concept. These concepts typically entail dynamic motions and complex computations, especially in the z-axis. The engineering problem that are given to these students typically need to be addressed by using the relevant formulas, and doing so may lead to a series of working steps before the final answer can be obtained. The learning software for engineering that is now available on the market is incapable of integrate the problem solving and visualization module with flipped classroom approach. The findings from the empirical data indicated that the software an encouraging impact on the learning outcomes of engineering student. Students of mechanical engineering could benefit from using the enhanced TAPS software since it could increase their learning interest and improve their visualization capacity, which would ultimately contribute to the addressing of engineering problems in accordance to the trends of engineering education 4.0.

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Keywords: Computer aided learning, Engineering education 4.0, Blended learning, Flipped classroom approach

1. Introduction

Engineering Education 4.0 encourage the integration of Information and Communication Technology (ICT) in promoting the student-centered learning. The enhanced technology assisted problem solving (TAPS) software with flipped classroom approach, is a web-based software application developed for engineering students to overcome their difficulties in learning Mechanics Dynamics course. Mechanics Dynamics is a fundamental course in Mechanical Engineering. The students stated that they had trouble visualizing problems and comprehending the problems given particularly those involving dynamic motion and complex calculations involving the z-axis and that they preferred the step-by-step approach to solve a problem [1]. According to prior research, the ICT technologies have a positive impact in terms of greater simulation and engagement in the students' learning process [2].

During the COVID-19 pandemic, most of the classes in tertiary education were shifted to online learning. Research indicated that digital learning may seem to be useful in enhancing the students' engagement, however it highly depends on students' ability to make use of this learning approach [3]. In addition, students also reflected that they can hardly focus during online class [4]. The COVID-19 outbreak prompted the implementation of flipped classrooms in higher education [5]. The flipped classroom is one of the rotation models in blended learning implementation. Blended learning is defined as a method of learning that incorporates a variety of learning approaches especially combined with the ICT technology in order to give a greater impact on student learning process [6].

The flipped classroom approach has a positive impact on engineering education and encourages active interaction between instructors and students. A flipped classroom can help engineering educators cover more information than a typical classroom [7]. In traditional classrooms, lecturers use class time to teach students, while students typically learn new knowledge in class. Bergmann and Sams created the notion of the flipped classroom in 2007 to alter traditional learning patterns and teacher-centered forms of learning [8]. Flipped classroom was described in the broadest sense as the transfer of traditional classroom instruction to outside environments via various media and the conduct of learning activities in the classroom to enhance the students' learning outcomes [9] . Furthermore, the flipped classroom concept is compatible with active learning, which encourages students to actively participate in teaching activities rather than passively or blindly listening and learning.

In this post-pandemic era, it is found that current existing engineering software could not integrate problem solving and visualization module with flipped classroom approach. The utilization of a flipped classroom approach would allow the educators and students to have a more interesting interaction and maximize the knowledge transferring process. Thus, in assessing the post -pandemic engineering education, the enhanced TAPS software will not only serve as a supporting tool in visualization and problem solving but also integrate the software in a blended learning setting using flipped classroom approach.

2. Materials and Methods

The enhanced TAPS software with flipped classroom approach was designed to facilitate the engineering students learning process, especially in problem solving and visualization for the Mechanics Dynamics course. The classroom design based on flipped classroom approach can be referred to **Figure 1**.

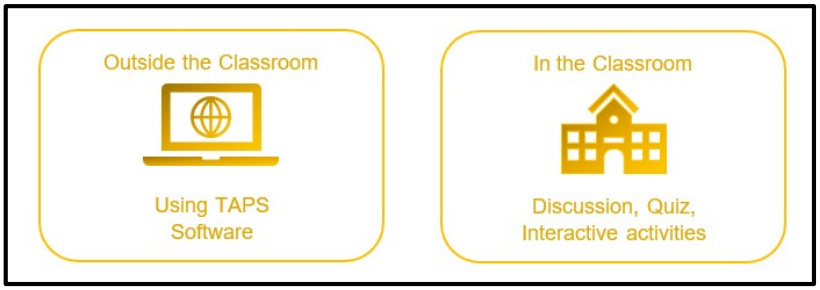

Figure 1: Enhanced TAPS Software with Flipped Classroom Approach

The flipped classroom approach encourages the students to use the enhaced TAPS software outside the classroom, while during the time in the classroom is used for discussions, quiz and interactive activities. It promotes students' active learning by review the learning contents before the classes and interact more with peers and instructor in the class. In this environment, the students will be exposed to a student-centered approach and more quality face-to-face interaction [10].

Figure 2 shows the authoring process for the TAPS software development. Multimedia authoring is the process of designing and developing a multimedia product. The authors combined and integrated different media components (text, graphic, audio, video, animation and interactivity elements) into one application and provides structure, navigation, and interactivity for the students.

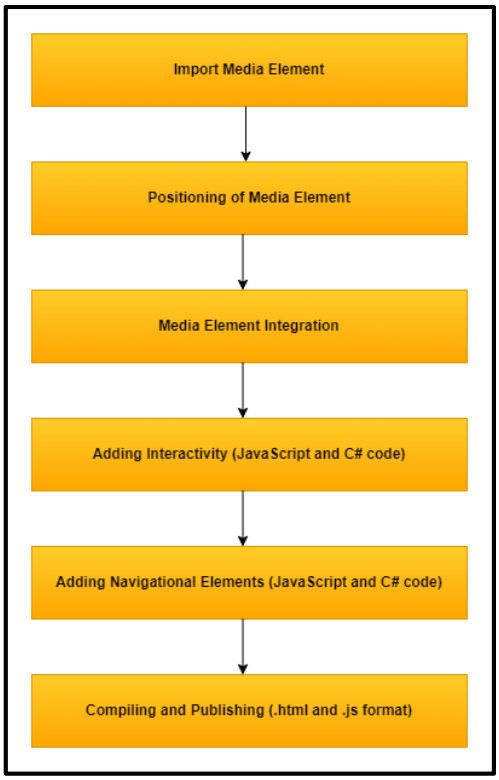

Figure 2: Authoring Process for Multimedia Software Development

Figure 3 presents the modules and the flow of the system. The student will first enter to a login screen, then proceed to the main menu of the software. The enhanced TAPS software consists of six modules, which can facilitate the students in concept understanding, step-by-step problem solving and visualization. For example, the student enters to the solution module. In the solution module, the software will cover the step-by-step solutions to guide the students in problem solving. Tips will be given to students in every step as a supplement knowledge for problem solving. Moreover, the software also facilitates students for better visualization through the 2-D and 3-D animation of the engineering model. Besides that, the students can also explore the modules in the system like concept module,

problem module, graph module, exercise module and nomenclature module to enhance their knowledge in learning Mechanics Dynamics.

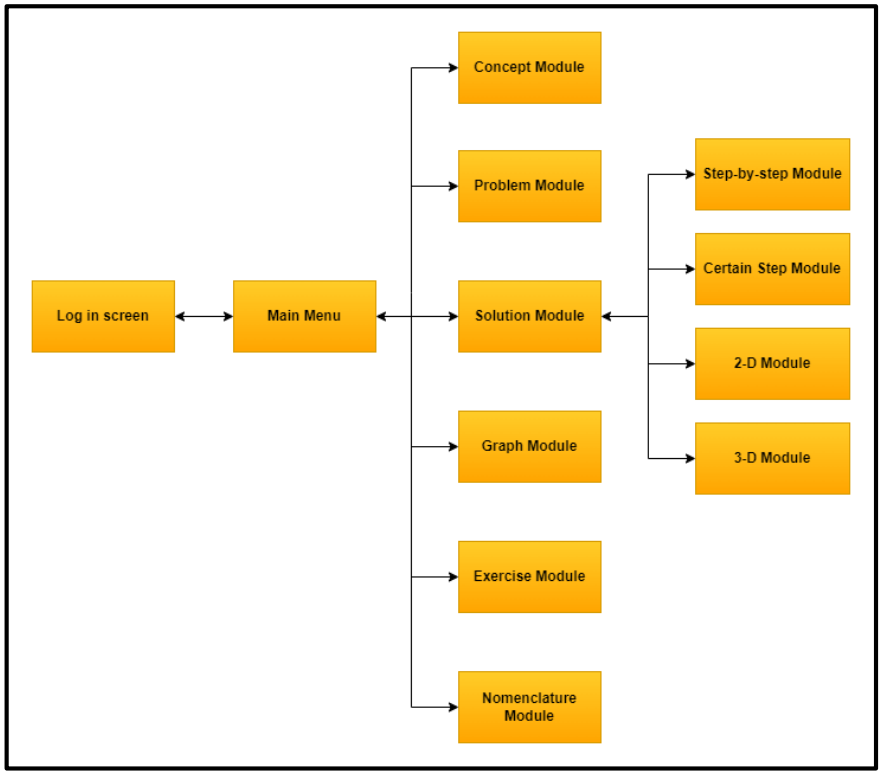

Figure 3: Modules in the enhanced TAPS Software

3. Results and Discussion

As mentioned above, this study aimed to apply the innovative learning pedagogy, flipped classroom approach to conduct a student-centered learning environment in Mechanics Dynamics course. A research study was conducted in order to collect the response of the students after using the TAPS software. A pilot study has been done on 21 students from Universiti Tenaga Nasional Malaysia (UNITEN) who took Mechanics Dynamics course before.

Table 1 shown the result of the students perception after using the software. The result of the pilot study shown that more than 70.0% of the students had a positive experience after using the TAPS software. Particularly, 71.4% and 23.8% of the students think their level of knowledge for this course are good and very good after using this supporting software. 57.1% and 28.6% of the students think their exposure (learning experience) for the blended learning are good and very good

Table 1: Students Perception after using the TAPS Software

	Very Poor	Poor	Acceptable	Good	Very Good
Overall, I think my level of knowledge for this course is _____ after using this supporting software.	0 (0.0%)	0 (0.0%)	1 (4.8%)	15 (71.4%)	5 (23.8%)
Overall, I think my exposure (learning experience) for the blended learning using flipped classroom approach is _____ after using this supporting software.	0 (0.0%)	0 (0.0%)	3 (14.3%)	12 (57.1%)	6 (28.6%)

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ICT often serve as an important role in engineering education particularly in providing supporting tool to assist students' learning process. From the students' response in Table 1, the findings indicated that their understanding level were good (71.4%) and very good (23.8%) after using the enhanced TAPS software. TAPS software integrated with flipped classroom approach provide students an active learning tool with step-by-step problem solving and visualization module. The findings from the pilot study are consistent with other scholars findings. Research from Fang claimed that a good visualization and demonstration tool can help students in concept understanding and prevent misunderstanding [11], [12]. Besides that, research by Mandal indicated that using animation and video as a supporting tool in engineering classroom will also motivate the students' learning interest [13]. Moreover, data in Table 1 explained that most of the students' exposure (learning experience) for the blended learning using flipped classroom approach were good (57.1%) and very good (28.6%) after using this supporting software. The integration of learning software with flipped classroom approach can help student to have a more quality classroom interaction [14].

4. Conclusion

In this paper, the results and findings regarding the use of enhanced TAPS software with flipped classroom approach in the blended learning environment were presented. The findings showed the positive learning outcome (understanding level and learning experience) after using the enhanced TAPS software. Future research would focus on a larger sample size which further investigates the efficacy of the enhanced TAPS software with flipped classroom approach in engineering education.

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